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FINAL TECHNICAL REPORT

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AFOSR F49620-93-1-0507

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FINAL TECHNICAL REPORT

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Nozer D. Singpurwalla, Principal Investigator

Research under the above grant deals with the general area of reliability theory and quality control. An emphasis here is on problems emanating from the area of software engineering, especially software reliability and software testing. In all 6 papers have been published or accepted for publication in the open literature, and 2 are currently under review. In the latter category, one of the papers deals with the topic of *warranties*, an issue which is relatively less formally researched but which appears to be growing in importance with respect to both military and commercial systems (to include both hardware and software).

1. Software Certification and Reliability Growth.

In the general area of software reliability 2 papers (see references 2 and 5) have been written, one of which has appeared in print and the other accepted for publication. The first one deals with the important problem of how much testing needs to be done to a piece of software before it is released for use. The problem is formulated as one involving decision under uncertainty and a mathematical expression for obtaining the optimum test time has been developed. The approach has been codified for use on a personal computer and this software is included in a package of programs for reliability analysis that is currently being developed. A use of this approach calls for a specification of the costs of testing and the costs of failure during operation. Unfortunately, only the case of single stage testing has been rigorously addressed. The more realistic case of sequential testing poses horrendous technical difficulties and remains to be addressed. Work on this topic continues.

plans) and implemented for use.

3. Accelerated Life Testing

Accelerated life testing is routinely done in reliability assessment. The existing procedures for inference from accelerated tests are predominantly non-Bayesian; their disadvantage has been an inability to incorporate engineering judgment into the analysis of data from accelerated tests. The use of such judgments is the operating norm in practical applications of accelerated tests. Viewing an accelerated test as an operation in filtering, with suitable priors to reflect engineering judgment offers hope, and a proposal to do the above was advocated by the PI. An implementation of this approach to some real live data from a biological context was undertaken under the aegis of this grant; see reference 3. The aim here was to demonstrate the feasibility of the proposed approach and to describe the practical nuances that occur when one attempts to undertake it.

4. Dependence in Reliability

The notion of dependence is central to the current research in reliability theory; the usual assumption of independence has resulted in unsatisfactory assessments. The fact that dependence is a *conditional* notion has not been explicated in the literature in reliability. Under the aegis of this grant (see reference 1), such conditioning is emphasized and the idea is further explored by making the conditioning parameter random. This work is of a foundational nature.

5. Warranties

Whereas consumers are used to acquiring products that are warranted by the manufacturer, the government, particularly DOD, may soon be moving more aggressively in that direction. It is very

likely that warranties may be mandated in the future procurement activities of the DOD. The problem of optimum warranties is a multi-disciplinary one, which involves among other things, issue of reliability and renewal theory. Under the aegis of this grant the problem of warranties has been scoped out (see references 6 and 8) and specific issues germane to the problem addressed. Of particular interest is the need to develop a new class of failure models that are indexed by two scales, time and usage. Work in this area is currently in progress. The topic of warranties promises to become a full-fledged multidisciplinary research area in the mathematical sciences.

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Papers

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